

In the claims:

1. (Amended) A method of perforating a subterranean formation which is penetrated by a wellbore, the wellbore having casing cemented therein, a cement sheath around the casing, so as to establish fluid communication between the formation and the wellbore, the method comprising the steps of:

perforating the casing using a mechanical perforator; and thereafter

igniting a propellant material disposed in the perforated casing;

creating a high-energy fluid stream of the propellant;

substantially vacating the propellant from within the casing; and

fracturing the cement sheath and subterranean formation.

thereby perforating the cement sheath.

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2. (Original) A method as in 1 further comprising the step of stimulating the formation with an acid stimulator.

3. (Original) A method as in 1 wherein the step of perforating the casing using a mechanical perforator further includes perforating at least some distance into the cement sheath.

4. (Original) A method as in 1 wherein the mechanical perforator comprises at least one toothed wheel.

5. (Original) A method as in 4 wherein the at least one toothed wheel included extendable teeth.

6. (Original) A method as in 1 wherein the mechanical perforator comprises needle-punch perforator.

7. (Original) A method as in 1 wherein the propellant material comprises a propellant stick.

8. (Original) A method as in 1 wherein the propellant material comprises a propellant sleeve.

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9. (Original) A method as in 1 wherein the step of igniting the propellant material further comprises expelling an abrasive material through the perforations in the casing thereby scouring the perforations in the cement sheath.

10. (Canceled).

11. (Original) A method as in 9 wherein the abrasive material acts in part to perforate the formation.

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12. (Original) A method as in 1 further comprising the step of deploying in the casing a perforator subassembly including the mechanical perforator.

13. (Original) A method as in 12 wherein the mechanical perforator includes at least one toothed wheel.

14. (Original) A method as in 1 further comprising the step of deploying in the casing a propellant subassembly including the propellant material.

15. (Original) A method as in 14 wherein the propellant subassembly further comprises an abrasive material.

16. (Original) A method as in 15 wherein the step of igniting the propellant material further comprises expelling the abrasive material through the perforations in the casing.

17. (Original) A method as in 2 further comprising the step of deploying in the casing an acid stimulation subassembly for delivery of the acid stimulator to the formation.

18. (Original) A method as in 1 wherein the casing is expandable casing.
19. (Amended) An apparatus for perforating a subterranean formation which is penetrated by a wellbore, so as to establish fluid communication between the formation and the wellbore, the wellbore having casing cemented therein, a cement sheath around the casing, the apparatus comprising:
- a mechanical perforator subassembly for creating perforations at least in the casing; and
 - a propellant subassembly for creating perforations in at least the cement sheath, the propellant subassembly having a propellant selected to, upon ignition, create a high-energy fluid stream.
20. (Original) An apparatus as in 19 further comprising an acid stimulation subassembly for delivery of the acid stimulator to the formation.
- B2 21. (Original) An apparatus as in 19 wherein the mechanical perforator capable of perforating at least some distance into the cement sheath.
22. (Original) An apparatus as in 19 wherein the mechanical perforator subassembly comprises at least one toothed wheel.
23. (Original) An apparatus as in 22 wherein the at least one toothed wheel includes extendable teeth.
24. (Original) An apparatus as in 19 wherein the mechanical perforator subassembly comprises a needle-punch perforator.
25. (Original) An apparatus as in 19 wherein the propellant subassembly comprises a propellant stick.

26. (Original) An apparatus as in 19 wherein the propellant subassembly comprises a propellant sleeve.

27. (Original) An apparatus as in 19 wherein the propellant subassembly comprises propellant and an abrasive material for expulsion through the perforations in the casing created by the mechanical perforation assembly.

28. (Original) An apparatus as in 19 wherein the propellant subassembly is further capable of creating perforations in the formation.

29. (Original) An apparatus as in 27 wherein the abrasive material is capable of perforating the formation.

30. (Original) An apparatus as in 19 wherein the casing is expandable casing.

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31. (Original) A method of perforating a subterranean formation which is penetrated by a wellbore, so as to establish fluid communication between the formation and the wellbore, the method comprising the steps of:

cementing casing in the wellbore thereby creating a cement sheath around at least a portion of the casing;

perforating the casing using a mechanical perforator; and thereafter

igniting a propellant material disposed in the perforated casing;

creating a high-energy fluid stream which substantially vacates the casing; and

fracturing at least the cement sheath.

32. (Original) A method as in 31 wherein the step of cementing casing further comprises expanding the casing.

33. (Original) A method as in 31 further comprising the step of stimulating the formation with an acid stimulator.

34. (Original) Method as in 31 wherein the step of perforating the casing using a mechanical perforator further includes perforating at least some distance into the cement sheath.

35. (Original) A method as in 31 wherein the mechanical perforator comprises at least one toothed wheel.

36. (Original) A method as in 31 wherein the mechanical perforator comprises a needle-punch perforator.

B2 37. (Original) A method as in 31 wherein the propellant material comprises a propellant sleeve.

38. (Original) A method as in 31 wherein the step of igniting the propellant material further comprises expelling an abrasive material through the perforations in the casing.

39. (Original) A method as in 32 further comprising the step of stimulating the formation with an acid stimulator.

40. (Original) A method as in 32 wherein the step of perforating the casing using a mechanical perforator includes perforating at least some distance into the cement sheath.

41. (Amended) A casing perforator apparatus for perforating casing disposed in a wellbore, the apparatus comprising:

a perforator body; and

B2 ~~a plurality of~~ at least three toothed wheels movably mounted to the perforator body, each wheel having a different axis of rotation.

42. (Canceled).

43. (Original) An apparatus as in 41 wherein at least one of the toothed wheels has extendable teeth.

44. (Original) An apparatus as in 41 further comprising means for moving the toothed wheels into contact with the casing.

45. (Original) An apparatus as in 41 wherein the casing is cemented in the wellbore, having a cement sheath around the casing.

B3 46. (Original) An apparatus as in 45 wherein the plurality of toothed wheels have teeth capable of perforating at least some distance into the cement sheath.

47. (Original) A casing perforator apparatus for perforating casing disposed in a wellbore, the apparatus comprising:

a perforator body;

~~and~~ at least one toothed wheel movably mounted to the body, each wheel having a plurality of extendable teeth movable between a retracted position and an extended position; and

a propellant subassembly having a propellant designed to create a high-energy fluid stream capable of substantially exiting the casing through perforations therein.

48. (Original) An apparatus as in 47 the at least one toothed wheel comprising three toothed wheels.

49. (Original) An apparatus as in 47, each toothed wheel having an actuator for moving the teeth to the extended position.

50. (Original) An apparatus as in 49, each toothed wheel having a locking mechanism for at least temporarily locking the teeth in the extended position. =

51. (Amended) A casing perforator apparatus for perforating casing disposed in a wellbore, the apparatus comprising:

a perforator body; and

a plurality of perforator needles movable between a retracted position and an extended position; and

an actuating means for moving the needles from the retracted position to the extended position;

a propellant subassembly having a propellant design ed to create a high-energy fluid stream capable of substantially exiting the casing through perforations therein.

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52. (Original) An apparatus as in 51 the actuating means capable of moving the needles from the extended position to the retracted position.

53. (Original) An apparatus as in 51 wherein the needles are shearable from the perforator body.

54. (Original) An apparatus as in 51 wherein the needles are mounted in a generally radial position when in the retracted position.

55. (Original) An apparatus as in 53 wherein the needles are soluble in acid solution.

56. (Original) An apparatus as in 51 wherein the actuating means is a substantially conical expansion plug.

57. (Original) An apparatus as in 51 wherein the casing is cemented in the wellbore a cement sheath around the casing.

58. (Original) An apparatus as in 57 wherein the needles are capable of perforating through the casing and at least some distance into the cement sheath.

59. (Amended) A method of perforating a casing in a wellbore, the method comprising:

positioning a perforator in the casing, the perforator having a plurality of perforator needles movable mounted thereon, the needles in a retracted position; and moving the needles to an extended position and perforating the casing with the needles;

creating a high-energy fluid stream which substantially vacates the casing; and
fracturing at lest the cement sheath.

60. (Original) A method as in 59 further comprising the step of moving the needles from the extended position to the retracted position.

61. (Original) A method as in 59 further comprising the steps of disconnecting the needles from the perforator.

62. (Original) A method as in 61 further comprising dissolving the needles.

63. (Amended) A method as in 59 wherein the step of moving the needles includes moving an ~~extension~~ expansion plug through the perforator.

64. (Original) A method as in 59 wherein the casing is cemented in the wellbore, a cement sheath around the casing, and further comprising the step of perforating at least some distance into the cement sheath.

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